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Report to the Honorable John P. Murtha, Chairman, Subcommittee on Defense, Committee on Appropriations, House of Representatives

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MILITARY SPACE OPERATIONS

Operational Problems Continue With the Satellite Control Computer System

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Information Management and
Technology Division

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The Honorable John P. Murtha
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

At the request of your predecessor we examined the efforts the United States Air Force has made to make its new satellite control system, Data System Modernization (DSM), fully operational. The DSM computer system is intended to replace an outdated system. It is designed to provide command and control instructions to support the launch and maintain the operation and position of on-orbit satellites that provide critical defense communication, navigation, surveillance, and weather services.

As agreed with your office, this report provides information on (1) whether DSM is meeting operational and performance requirements, (2) hardware and software changes the Air Force has made to satisfy operational and performance requirements, and (3) current schedule and cost estimates to complete the system. Appendix I describes our objectives, scope, and methodology in more detail.

We reported in 1988[1] that the Air Force's cost and schedule estimates for a fully operational DSM were overly optimistic and that performance deficiencies were delaying the transition of DSM to an operational status. Although progress has been made, critical operational and performance problems with the computer software and hardware continue to prevent DSM from assuming the full satellite control work load. As a result, the Air Force must rely on an outdated satellite control system (Current Data System) to perform a portion of the satellite control work load. Specifically, in March 1989 the Air Force was relying on DSM alone to control about 55 percent of the satellite contacts. An additional 23 percent of the contacts were being controlled by DSM with either backup or partial support from the Current Data System. The remaining 22 percent of the satellite contacts were being controlled entirely by the Current Data System. While the Air Force is addressing DSM's known deficiencies, it continues to identify additional deficiencies that also

[1] Military Space Operations: Shuttle and Satellite Computer Systems Do Not Meet Performance Objectives (GAO/IMTEC-88-7, Aug. 5, 1988).

must be resolved. In 1985 the Air Force planned to have DSM fully operational by 1988; however, because of operational deficiencies that were due in part to new requirements, the transition of all operations to DSM is now planned for the end of 1993. The Air Force estimates the cost for the system to be at least $557 million.

Background

DSM is replacing the Current Data System, an outdated satellite command and control computer system that has been in use for more than 20 years. The Air Force expected the new computer system to increase performance and reduce costs by replacing obsolete computers, centralizing real-time[2] data processing, simplifying operations, and providing redesigned software to allow the mission controllers to use the system on a real-time basis. The DSM modernization began in 1981. The DSM system is being installed in the two satellite command and control centers of the Air Force's Satellite Control Network—the Consolidated Space Test Center (test center) in Sunnyvale, California, and the Consolidated Space Operations Center (operations center), near Colorado Springs, Colorado. These centers are part of the Air Force's satellite control network and are operated by the Air Force Systems Command and Air Force Space Command, respectively. The network consists primarily of worldwide, fixed, ground-based tracking stations; the test center and the operations center; dedicated control stations; and communication links connecting these components. The network is responsible for supporting the launch of military communication, navigation, weather, and surveillance satellites and maintaining the operation and orbit of these satellites. Appendix II illustrates the major elements of the Satellite Control Network.

In March 1989 the test center and the operations center were supporting about 60 orbiting satellites and were planning to support the launch and control of an additional 17 satellites over the remainder of 1989. Mission control complexes at these centers support activities related to preparing for and rehearsing the launch, taking control of the satellite after launch, contacting the satellite to verify its operational status, and resolving any problems with the satellite's on-board systems.

[2]A computer system that supports real-time processes must produce an appropriate response to certain events and conditions within a specified time constraint.

DSM provides computer support for the seven separate mission control complexes at the test center and the three separate mission control complexes at the operations center. Each mission control complex is responsible for controlling a specific type and number of satellites. A mission control complex provides support for the launch of a program's satellites and then maintains their operations and keeps satellites in their proper orbit. Once DSM becomes fully operational at both centers, the operations center will assume primary support for most operational military satellites and the test center will primarily support future research and development programs and selected Department of Defense and other agency programs.

DSM Does Not Fully Meet Operational and Performance Requirements

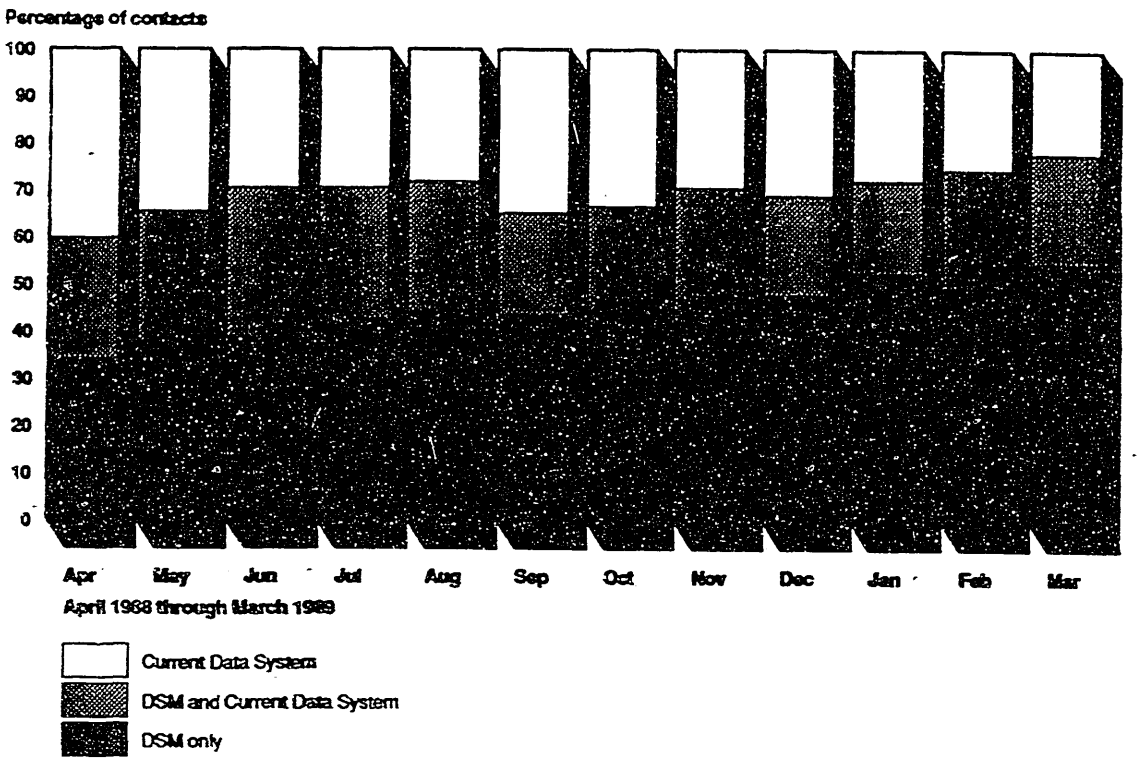
While DSM is the primary system being used to support the satellite contact work load for some satellite programs and has been successfully used to support some recent satellite launches, critical operational and performance deficiencies remain. Although the Air Force has worked at resolving DSM deficiencies, about 900 critical deficiencies[3] remained unresolved as of April 1989. These identified deficiencies and others that continue to be identified, including those arising from new requirements, are preventing DSM from (1) processing the entire satellite control work load without continued use of the Current Data System, (2) achieving the required satellite contact success rate, and (3) simultaneously contacting the required number of satellites in some of the mission control complexes.

DSM Is Not Performing All the Satellite Control Work Load

As of March 1989, DSM was not fully operational, and the Current Data System was still needed to help handle the satellite control work load. For example, as figure 1 shows, in March 1989, DSM alone performed about 55 percent of the satellite contacts. An additional 23 percent of the contacts were made using both the DSM and the Current Data System. (That is, DSM performed the contact but was backed up by the Current Data System or the Current Data System was used to perform some functions not yet available with DSM.) The remainder of the contacts (22 percent) were done entirely by the Current Data System.

[3]The Air Force considers these problems critical because they must be resolved before the command and control work load can be completely moved from the Current Data System to the DSM.

Figure 1: DSM and Current Data System Satellite Contacts



In addition to not performing the entire satellite contact work load, DSM was not supporting all activities associated with mission planning for the launch and control of satellites and for evaluating the performance of satellites after a contact. For example, in February 1989, for two of the satellite programs at the test center, DSM was supporting only 40 percent and 21 percent, respectively, of the mission planning and evaluation work load.

DSM Is Not Satisfying Contact Success Rate or Simultaneous Contact Requirements

Measurements of DSM performance include the percent of satellite contacts that are deemed successful and the number of satellites a single mission control complex can control simultaneously. The Air Force requires a 95 percent contact success rate for DSM.[4] In March 1989, the average satellite contact success rate for all the DSM contacts was 93 percent—up from the 80 percent success rate the system averaged in January 1988. However, this success rate does not take into consideration those contacts that were performed partially or fully by the Current Data System. If these were taken into account, the March 1989 success rate would have decreased to about 69 percent.

Further, DSM has been unable to satisfactorily control the required number of simultaneous satellite contacts in most of the mission control complexes. DSM is required, for example, to be able to control at least five satellite contacts simultaneously in most of the complexes. However, as of February 1989, only one complex could control five simultaneous contacts as required; at most of the mission control complexes that required simultaneous contacts, the DSM could process only three.

Changes the Air Force Has Made to Satisfy Requirements

To resolve the system deficiencies and accommodate additional requirements, the Air Force has made changes to the computer system software and hardware. The computer hardware in most of the mission control complexes has been upgraded to allow an increased amount of data to be processed. This upgrade represents the third major upgrade since starting the development of DSM. In addition, on-line storage for some mission control complexes was increased by more than 50 percent. Further, an additional mission control complex was installed at each of the control centers to handle changes in the work load. In June 1989 Air Force officials acknowledged that DSM will continue to change as it will be required to satisfy new and evolving mission requirements and operations concepts.

From December 1987 through March 1989, about 20 major updates to the software had been incorporated. These updates involved fixing deficiencies identified by operational personnel and tailoring the software to each satellite program and mission control complex to satisfy current operational requirements. For example, in some cases DSM software was modified to provide operators with additional data or access to data that are critical to the launch or control of a satellite. In other cases, the

[4]The Air Force defines a successful satellite contact as one in which 90 percent of the telemetry and tracking requirements and 100 percent of the command requirements are met.

software was modified to refresh the terminal displays less frequently, thereby reducing the work load on the DSM computers and freeing the system to process other requirements.

Operational Schedule Has Slipped

In 1985 the Air Force planned to have DSM fully operational in all mission control complexes at the test center in 1987 and at the operations center in 1988. Schedule delays have occurred since then and the Air Force now estimates that DSM will be fully operational at both centers by the end of 1993. Air Force officials said in June 1989 that the schedule delays are attributable to system deficiencies, additional requirements, and funding limitations. However, given the number of years the Air Force has been working on DSM, we believe the Air Force's explanation for the delays raises questions concerning its ability to correct system deficiencies in a timely manner and whether the system design it chose for DSM is flexible enough to accept additional requirements.

At the test center, initial operational testing and evaluation of DSM for the first mission control complex began in February 1986 but was never successfully completed. According to the test center commander, there are no plans to reschedule initial operational testing and evaluation of the system. However, the Air Force performs tests on each software update and computer hardware change. At the operations center, initial operational testing and evaluation of the first mission control complex is planned to be completed in October 1989—a year later than we previously reported.[5] Final transition of satellite control to DSM at both the test center and the operations center, eliminating all reliance on the Current Data System, is scheduled for the end of 1993.

Whether the Air Force can meet its new schedule depends on the successful resolution of critical operational deficiencies being identified by the Air Force. As of April 1989, the number of unresolved deficiencies was about 900. Fixing these deficiencies will require changes to DSM software and hardware. According to the Air Force, the changes necessary to resolve the critical operational deficiencies should be completed by the end of 1993.

On the basis of a schedule issued in April 1989, approximately 600 of the 900 deficiencies are expected to be resolved through future computer software updates. Air Force officials stated that many of the remaining deficiencies may require additional computer hardware

[5]GAO/IMTEC-88-7, Aug. 5, 1988.

upgrades. For example, DSM computer hardware has had difficulty in meeting all display processing requirements. The current DSM architecture requires this processing to be performed in the main computer processor, which can become overloaded if too many terminals need to be on-line at the same time. One alternative being considered to correct this problem is the purchase of smaller computers so that the display processing can be off-loaded to them. This would be an interim step prior to moving the display processing to new display terminals that can independently perform this function.

Costs Continue to Increase

As of December 1988, Air Force documents show that about $458 million has been spent developing DSM and that total system costs will be at least $557 million to bring DSM to full operational capability. The Air Force is primarily using a sustaining engineering contract, awarded to International Business Machines Corporation—the original development contractor—to perform this work.

A major part of the sustaining engineering contract includes modifications needed to improve the DSM computer software and hardware. For example, software maintenance costs for fixing critical operational deficiencies is estimated at $40 million through September 1989. In addition, the contract includes about $59 million in computer system enhancements necessary to satisfy new DSM requirements. Some of the computer system enhancements include the installation of additional mission control complexes at the test center and the operations center; the upgrade of computer processors in mission control complexes to increase processor capacity; and the increase of on-line storage in some of the mission control complexes.

Moreover, 70 of the critical operational deficiencies require additional system enhancements for which no cost estimates were available at the time of our review. The Air Force also continues to identify additional deficiencies that will require more funding to resolve. Accordingly, the cost to field a fully operational DSM in all mission control complexes has not been fully developed. Further, because DSM is not completely operational and some satellite operations still depend on the Current Data System, the Air Force must continue to incur operational and maintenance cost on this outdated system. The Air Force estimates the Current Data System costs about $30 million annually to maintain.

Summary

The Air Force has spent about $458 million on DSM, a new satellite control computer system that is independently controlling about 55 percent of the satellite contact work load. An additional 23 percent of the contacts were being controlled by DSM with either backup or partial support from the Current Data System. While the Air Force has taken action to resolve some of the operational deficiencies, as of April 1989, about 900 critical deficiencies remained to be resolved before DSM can become fully operational. Costs continue to increase as the Air Force plans to spend about $99 million through September 1989 to improve DSM's computer hardware and software. The estimated date for when the new system will be fully operational in all mission control complexes continues to slip. Although critical system deficiencies are being addressed, more are being discovered. Until all deficiencies are resolved, the readiness of the Air Force Satellite Control Network is still dependent on using both DSM and the Current Data System.

We are sending copies of this report to the Secretary of Defense; the Secretary of the Air Force; the Chairmen, House and Senate Committees on Armed Services; Senate Committee on Appropriations; House Committee on Science, Space, and Technology; Senate Committee on Commerce, Science, and Transportation; and the Director, Office of Management and Budget. We will also send copies to other interested parties and make copies available to others upon request.

This report was prepared under the direction of Samuel W. Bowlin, Director for Defense and Security Information Systems, who can be contacted at (202) 275-4649. Other major contributors are listed in appendix III.

Sincerely yours,

Ralph V. Carlone
Assistant Comptroller General

Contents

Abbreviations

DSM	Data System Modernization
GAO	General Accounting Office
IMTEC	Information Management and Technology Division

Objectives, Scope, and Methodology

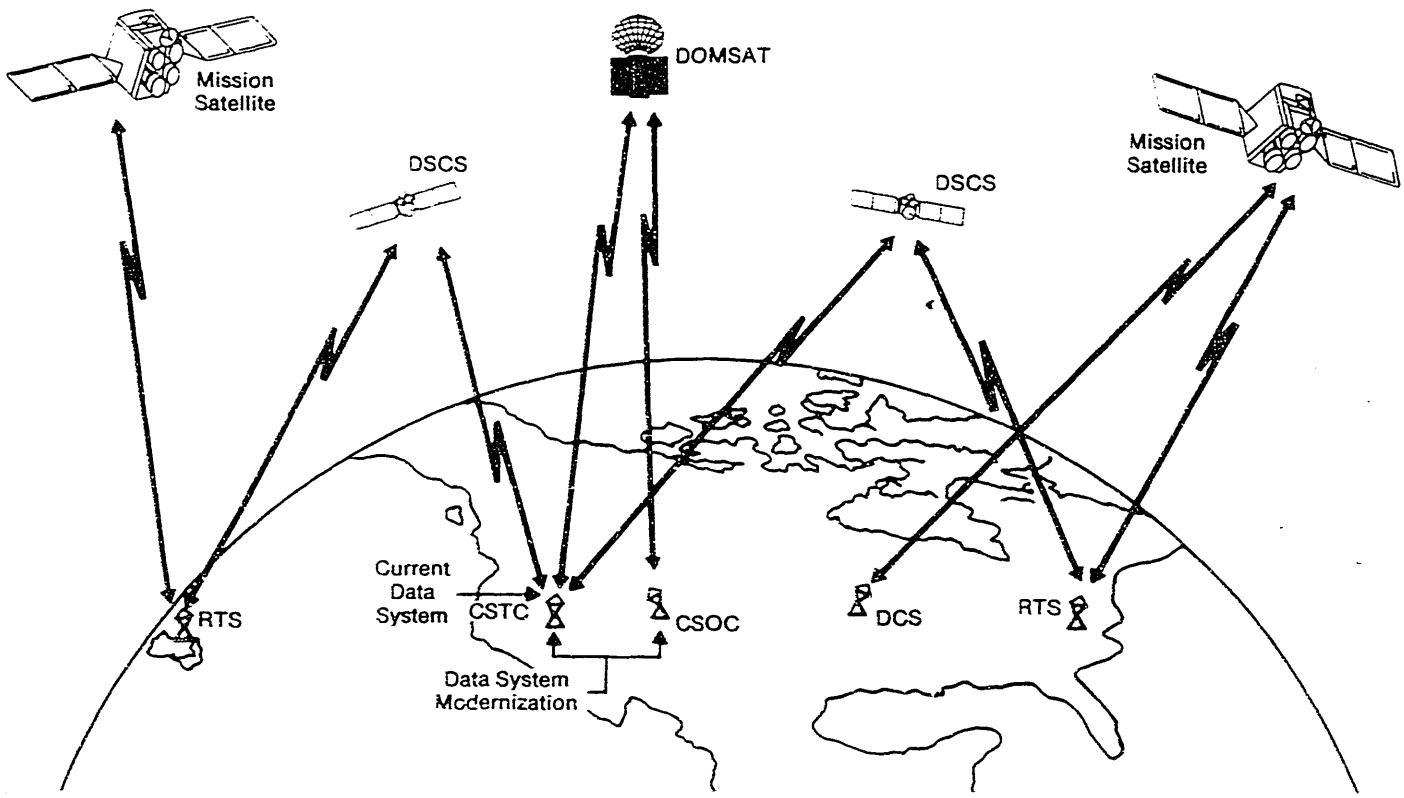
In response to a request from the former Chairman, House Committee on Appropriations, Subcommittee on Defense, and in subsequent discussions with Subcommittee staff, we agreed to provide information on Air Force efforts to complete development and make operational its new satellite control system—the Data System Modernization (DSM). To meet this objective we addressed three major concerns: (1) whether DSM was meeting operational and performance requirements, (2) hardware and software changes the Air Force has made to satisfy operational and performance requirements, and (3) current schedule and cost estimates to complete the system.

To obtain information on DSM's performance, we interviewed Air Force officials responsible for developing the system and reviewed relevant management, technical, and contract documents provided by the Air Force. We analyzed system performance data provided by personnel at the operational commands and discussed our findings with them. In addition, we obtained current program cost and schedule completion estimates. We also held discussions with Air Force headquarters and Air Force Space Command officials regarding actions being taken to meet DSM performance requirements.

Our work was conducted at Air Force headquarters, in Washington, D.C.; Space Systems Division at Los Angeles Air Force Base, California; Air Force Space Command headquarters, Peterson Air Force Base, Colorado: Consolidated Space Operations Center, Falcon Air Force Base, Colorado; and Consolidated Space Test Center, Onizuka Air Force Base, California.

In accordance with the Subcommittee's request, we did not obtain official agency comments on a draft of this report. However, we shared its contents and verified the factual information presented with Air Force officials, and have included their comments and made revisions where appropriate. Our audit work was conducted from July 1988 through June 1989, and was performed in accordance with generally accepted government auditing standards.

Air Force Satellite Control Network



RTS - Remote Tracking Station
DSCS - Defense Satellite Communications System
CSTC - Consolidated Space Test Center
DOMSAT - Domestic Satellite
CSOC - Consolidated Space Operations Center
DCS - Dedicated Control Station

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